Construction on Reclaimed Land Near the Bay

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Outline

- Project description and design requirements
- Ground improvement solution
- Construction challenges
- Better practice of ground improvement

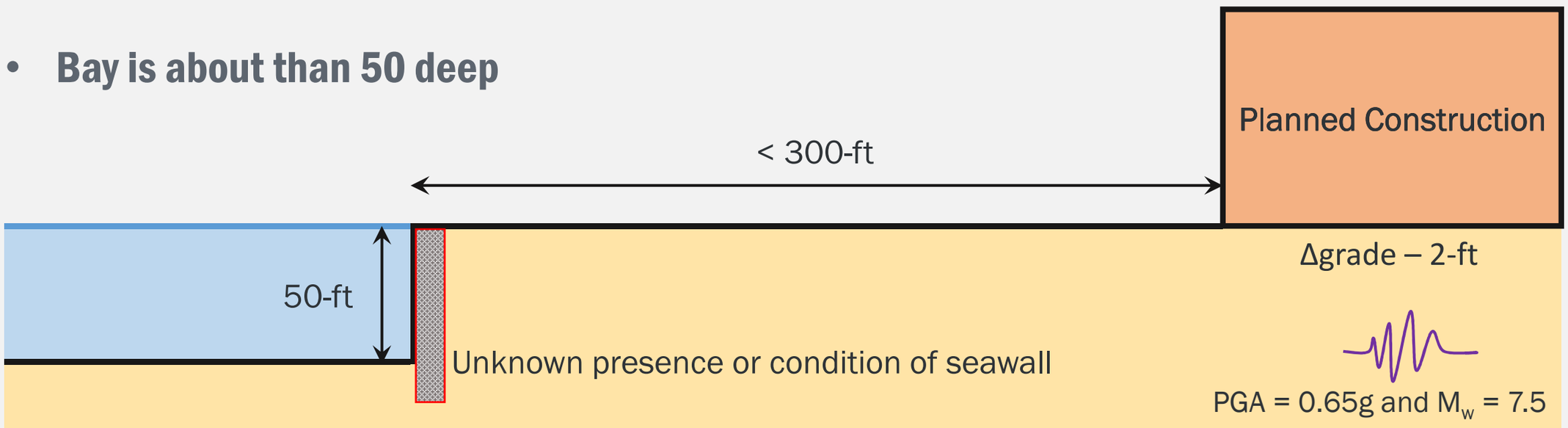
Proposed Improvement

- 8-Story residential building
- At grade with no basement
- Mat foundation
- Construction is limited to the building footprint.

Booth Hansen (2018)

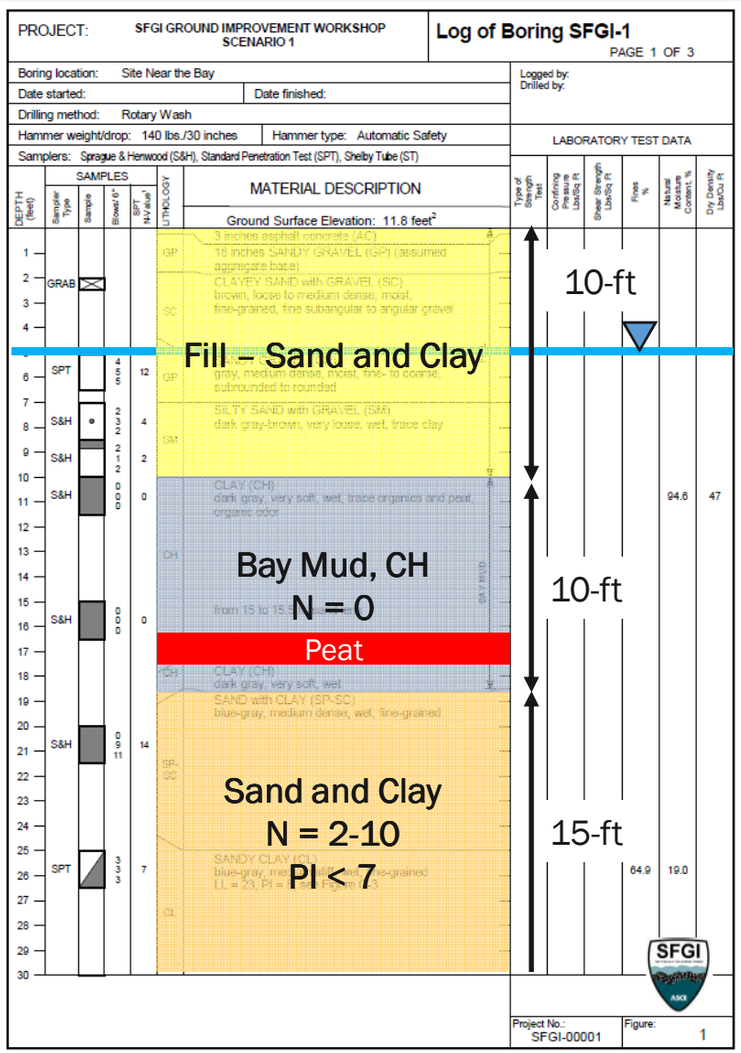
Surface Conditions

- Relatively flat with 2-ft grade change
- Less than 300-ft from shoreline
- Bay is about than 50 deep

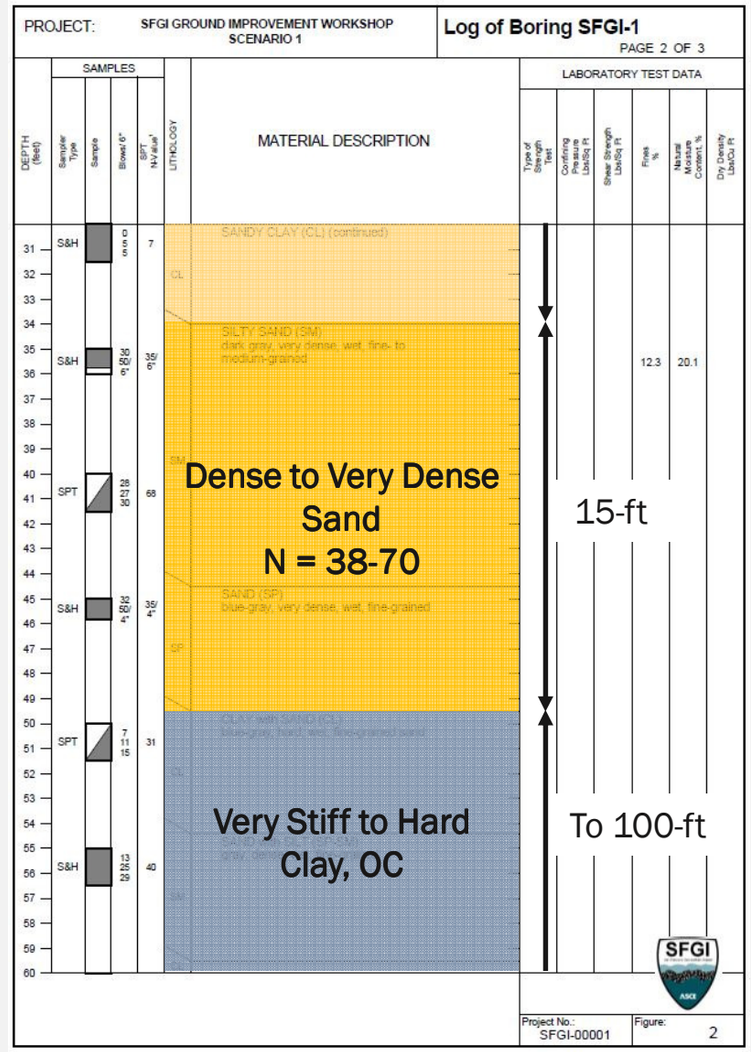


Subsurface Condition

Depth: 0- to 30-ft

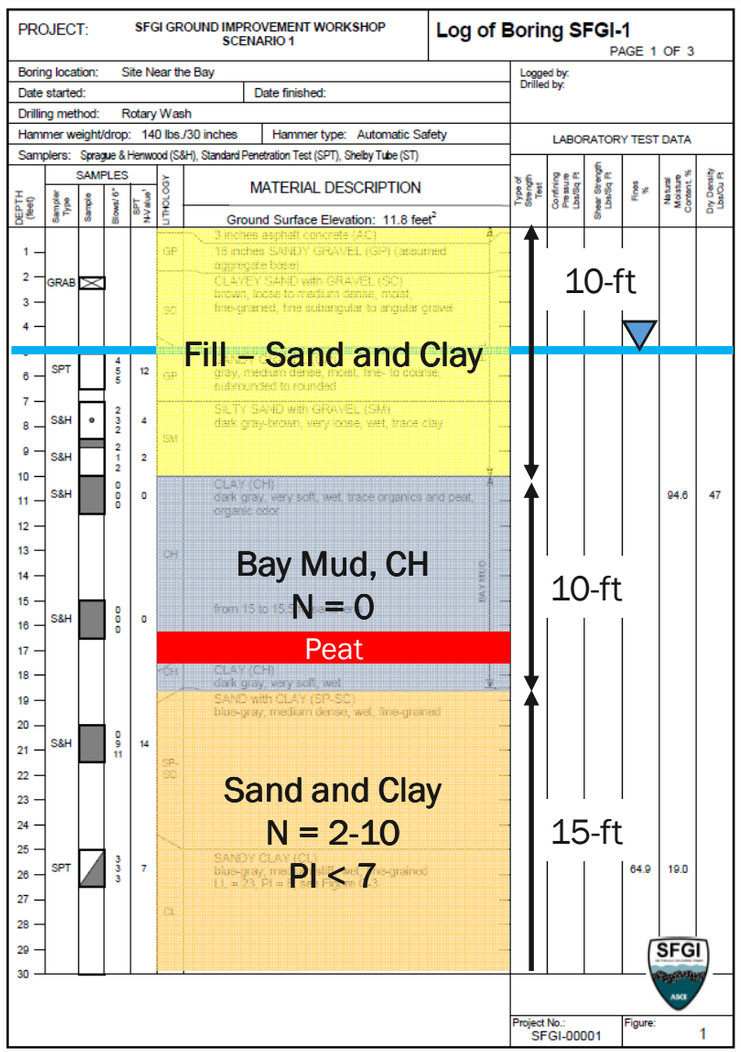


Depth: 30- to 60-ft



Identified Hazards

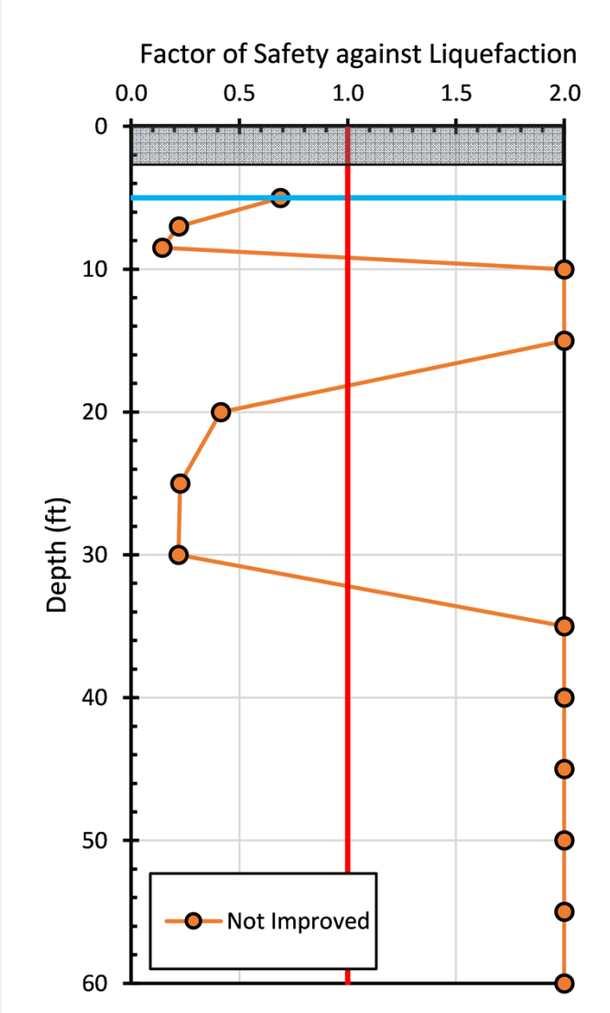
Depth: 0- to 30-ft



- Excessive static settlements
- Liquefaction of the sandy layer
- Lateral spreading toward the shoreline

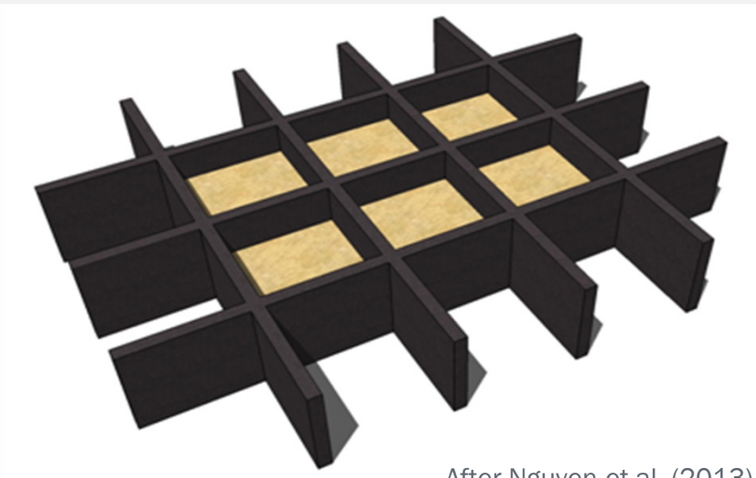
Liquefaction Analysis

- **Liquefaction triggering between 5- to 10-ft and 20- to 30-ft.**
  - Liquefaction settlement < 4-in.
- **Liquefaction damage potential:**
  - Severe with manifestation expected
- **Lateral spreading:**
  - Yoshimine et al. (2006): 5.2-ft
  - Zhang et al. (2004): 7.2-ft

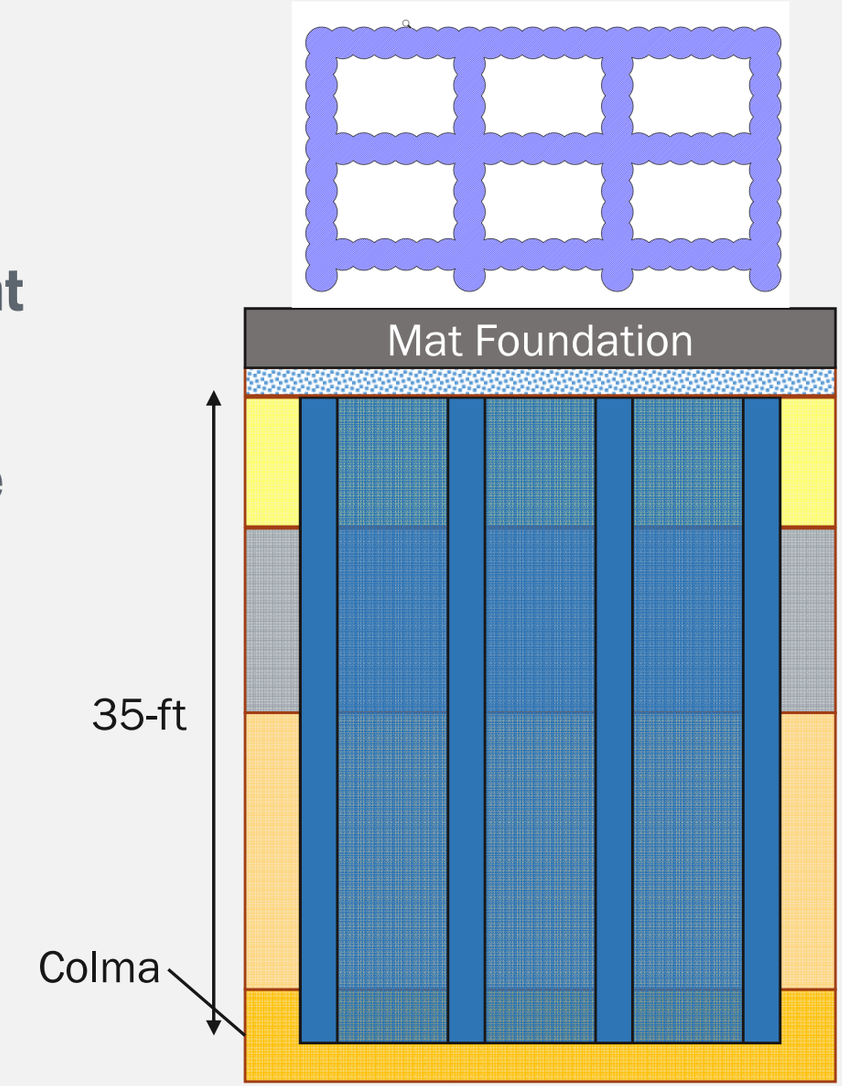


Ground Improvement Solution

- **Deep-Soil-Mixing (DSM) can be an efficient solution for the proposed project.**
- **DSM grids will enclose the loose soils and mitigate liquefaction through shear stress redistribution.**

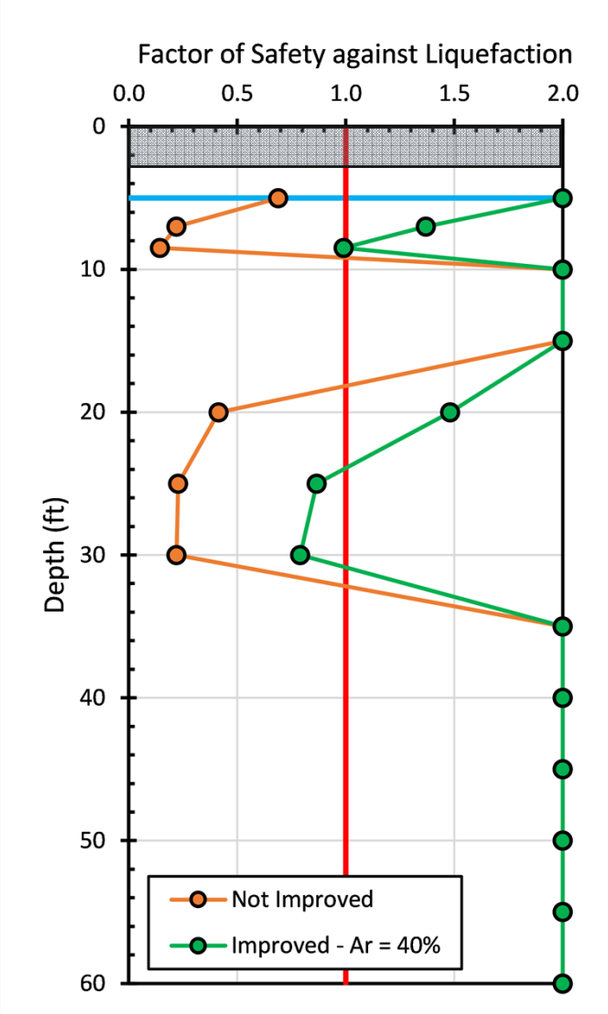


After Nguyen et al. (2013)

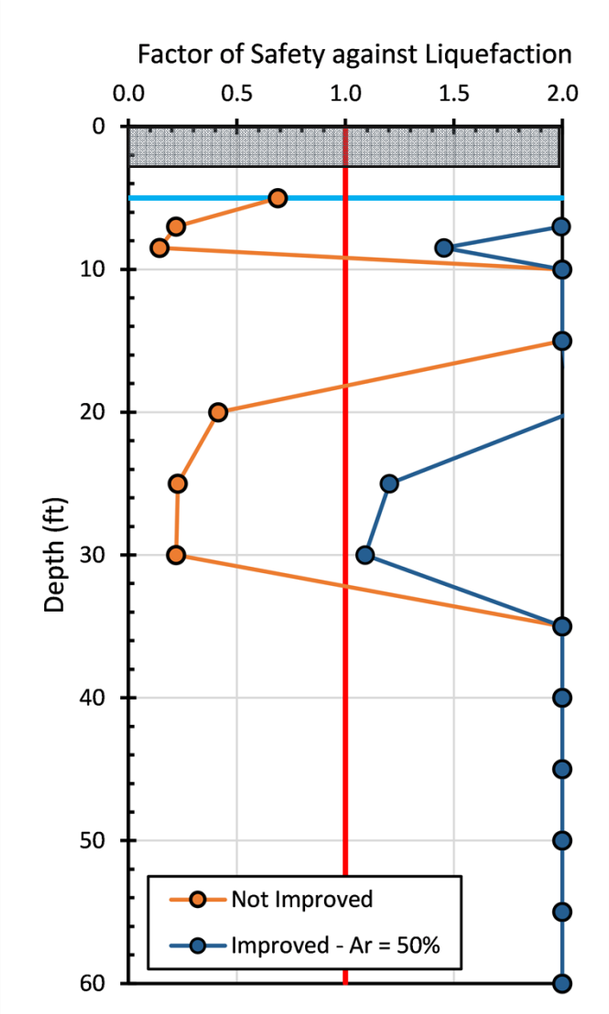


Liquefaction Mitigation

Area Replacement Ratio = 40%

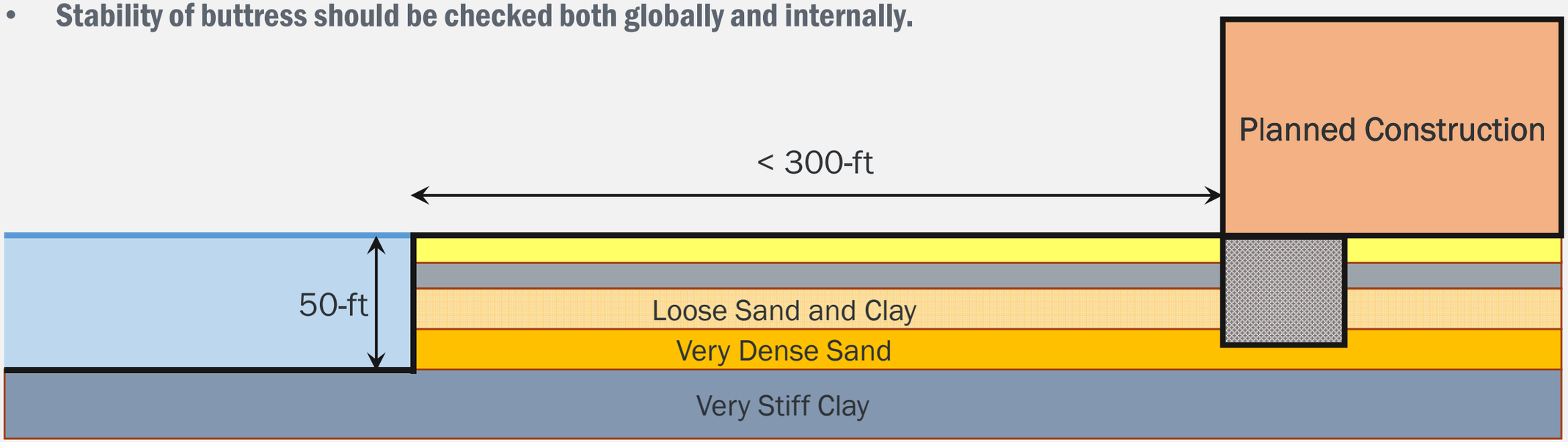


Area Replacement Ratio = 50%



Lateral Spreading

- Buttress should extend through the liquefiable materials, and toe into the underlying competent layers.
- Numerical modeling should be carried out to design the depth and extent of the buttress.
- Stability of buttress should be checked both globally and internally.



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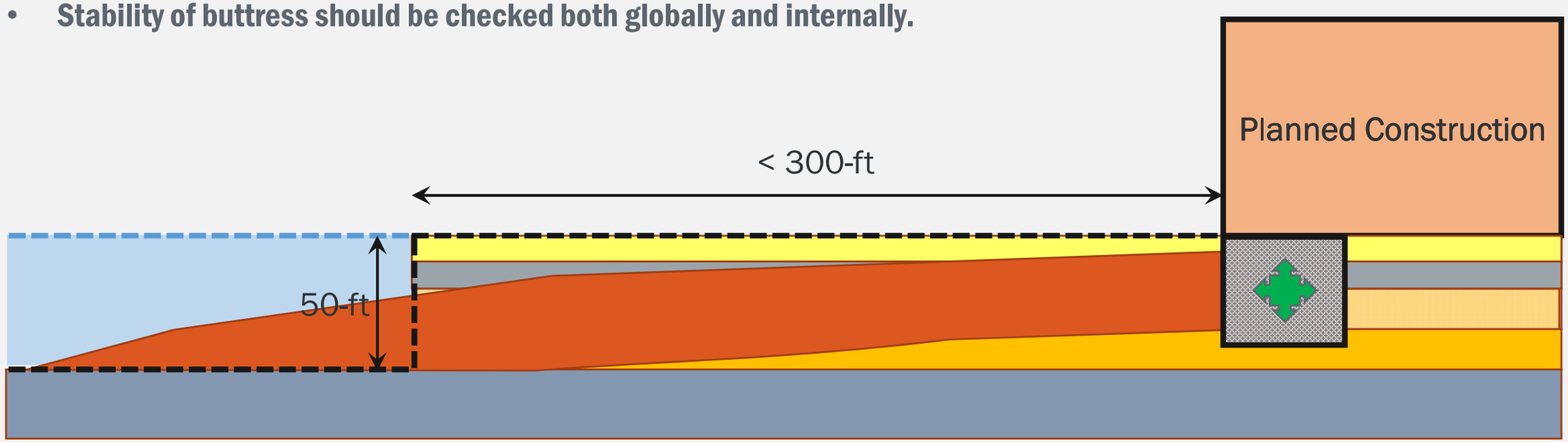
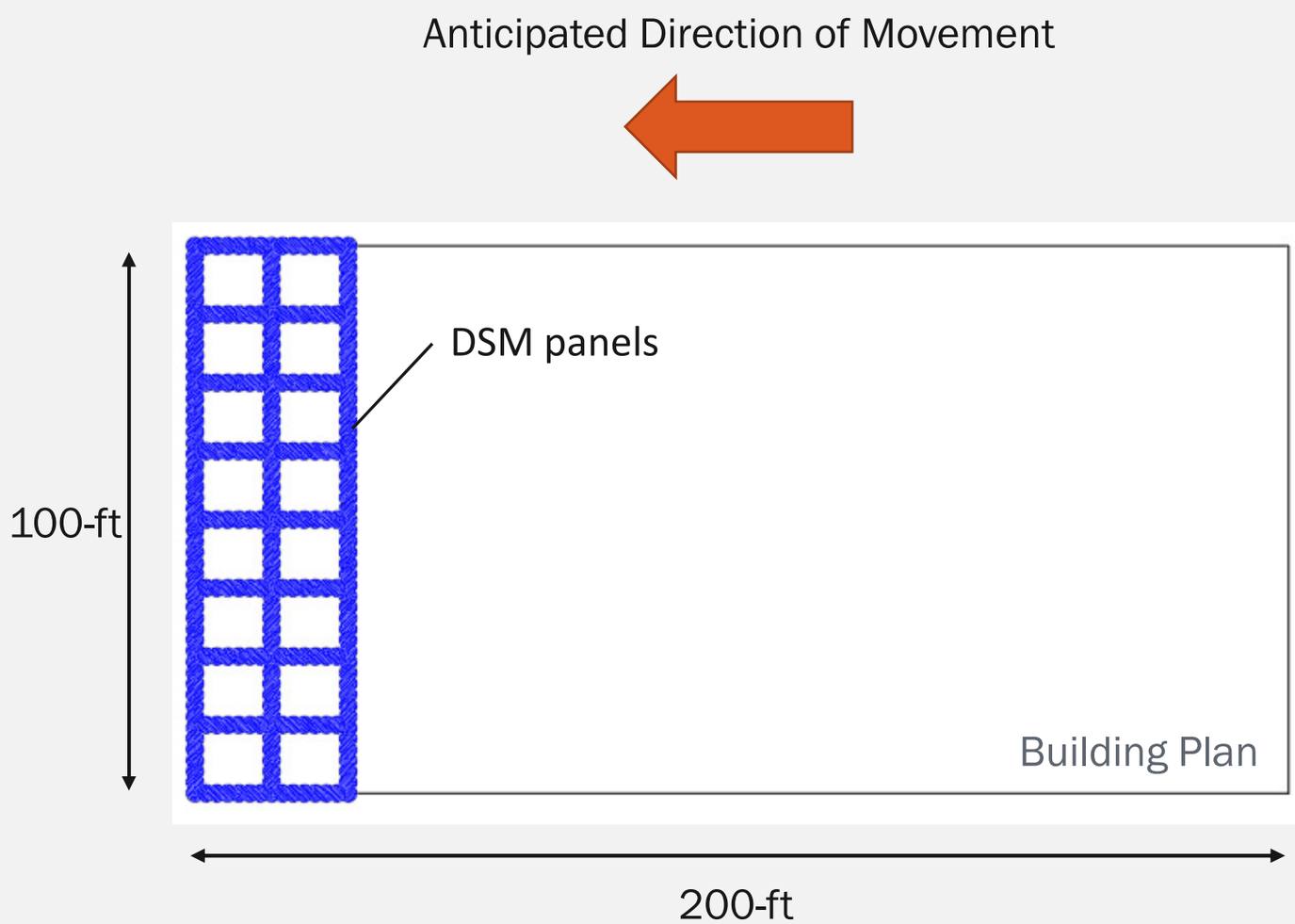


Buttress


Anticipated Direction of Movement
DSM panels
100-ft
Building Plan
200-ft

Deep-Soil-Mixing

Triple Auger Mixer

Cutter Head Mixer

DSM Grid

Construction Challenges

- Presence of peat poses a challenge to achieve the required soil-cement strength.

- Efficiently incorporating the soil-cement spoils into the final grading.

Better Practice of Ground Improvements

- Ground improvement designs are extremely dependent on our understanding of soil profile.
  - (1) Fine contents, (2) plasticity of soil, and (3) shear wave velocity measurements are crucial information for efficient design of ground improvements.
- Schedule allowance for test programs before production can help contractors to better ensure the quality of their work.
- Open discussions about future costs against today's construction costs can often result in great savings.

Summary

- DSM grids can be used as an efficient ground improvement solution for waterfront projects with focused footprint construction.
- DSM grids can be designed to meet the static bearing capacity and settlements, as well as, seismic liquefaction, surface manifestation and lateral spreading requirements.
- More information about the soil profile and properties can extensively help optimize the design of ground improvements.
- Open discussions about project priorities and better schedule planning can effectively help practice of ground improvements.